ATTACHMENT 1

WATER QUALITY FINANCIAL ANALYSIS AND RESOURCE EVALUATION (WQFARE)

This notebook has been assembled to provide you with information about the watershed within which you manage grazing resources and to guide you in the implementation of the Water Quality Financial Analysis and Resource Evaluation (WQFARE) on these resources. It consists of four major components:

I. WQFARE Process
II. Evaluation Section (contains material necessary to perform evaluations)
III. Planning Section (contains material for pasture planning)
IV. Support Materials (sources of relevant supporting information and data disk)

I. WQFARE Process

The WQFARE section consists of a WQFARE completion checklist, an introduction and a description of and guidance for completing Step 1-5 of the WQFARE process. This is followed by five attachments designed to support pasture evaluations, record keeping and the formulation of alternative management strategies.

II. Evaluation Section

The Evaluation section contains blank forms (for you to reproduce as needed) used for financial and pasture management record keeping. The Standardized Performance Analysis (SPA) financial record program has forms to record basic location and operating information, to track livestock reproduction and inventory data, balance sheet forms and income statement forms. Forms for pasture management records include a Management Information System data form and Pasture Use Record.

III. Planning Section

The Planning section includes a WQFARE planning summary template, a basin orientation map, a parcel location map illustrating roads and parcel locations within sub-basins. Following these items are sample alternatives (and maps if needed) developed for these parcels based on our experience with your grazing enterprise as of the time evaluations were performed.

IV. Support Materials

Support materials are provided and include applicable Extension publications and Kansas Department of Health and Environment (KDHE) water quality planning documents. Material provided varies and is denoted with a * on the Additional Sources of Information page. Included in the support material is a CD-ROM data disk. This data disk has been prepared so that you can access and print pasture maps. Orthophotmaps of your parcels have been prepared as digital (.jpg) images to facilitate pasture evaluations. This data disk also contains ArcExplorer[1] software, that, when installed, will allow the visualization and query of the enclosed data. Using ArcExplorer, pasture data may be overlayed onto the appropriate Digital Orthophotographic Quarter Quadrangle (DOQQ) contained in the Aerial Photography folder. Refer to the ArcExplorer2.txt (or .wpd) for installation information.

[1] ArcExplorer is GIS freeware manufactured by ESRI, Redlands, California.

Water Quality Financial Analysis and Resource Evaluation Stewardship Program

Prepared by the

Kansas Grazing Land Water Quality Program

This program is developing an educational program to promote voluntary improvement of water quality from Kansas grazing lands while maintaining profitability. Funding for the program is provided by the Watershed Management Section, Bureau of Water, Kansas Department of Health and Environment with funds from Section 319 of the Clean Water Act.

This document is a draft. Please use this document and let us know what we need to add, change, delete, or if you have other suggestions. Send your comments to:

Paul D. Ohlenbusch
Kansas State University
Department of Agronomy
2014 Throckmorton Hall
Manhattan, KS 66506-5504

Table of Contents

WQFARE Completion Check List

Please use this checklist as a guide for implementing the Water Quality Financial Analysis and Resource Evaluation (WQFARE) process on your grazing operation.

_____ Familiarize yourself with information in the "Introduction" and "Support Material" sections in the WQFARE notebook. This information will help improve your understanding and/or awareness of factors influencing grazingland water quality and economics.

_____ Conduct physical inventory (see "Step 1") on pastures in the management unit by recording the location and characteristics of problem sites and features affecting livestock use patterns.

_____ Evaluate results of the physical inventory for each pasture to determine problem sources (see "Step 2", page 6) by identifying relationships between problem sites, pasture features and livestock behavior. Summarize results under the 2nd item of the Planning Summary Template (see "Planning" section).

_____ Begin conceptualizing options for correcting problems (see "Step 2", page 6) by anticipating ways to modify negative consequences of livestock behavior.

_____ Review your existing business and lifestyle goals and objectives (see "Step 2", page 7) and record them at the top of WQFARE Planning Summary Template (see "Planning" section).

_____ Review and record current management resources and practices for each pasture (see "Step 2", page 7) to help ensure that management alternatives to be developed will complement or improve the resource balance of the operation. Blank Management Information System (MIS) Data and Pasture Use Record forms are in the "Evaluation Section" of this notebook

_____ Identify potential sources of financial or technical assistance (see "Step 2", page 7).

_____ File base maps, field notes and management data in "Evaluation" section in the notebook.

_____ Develop baseline profitability estimate(s) using current enterprise financial and production information. This includes developing accrual-adjusted beginning balance sheets and enterprise specific income statement(s) for each grazing or grazing-related enterprise (see Step 3). Standard accounting methods such as those used in Standardized Performance Analysis (SPA) should be used (see "Evaluation" section for blank SPA data forms. When complete, file baseline profitability estimate(s) in the "Evaluation" section for later use in a comparison with the economic implications of alternative management strategies.

WQFARE Completion Check List continued:

_____ Record any supplemental or modified goals in the WQFARE Planning Summary Template (see "Planning" section). New objectives for goals will be recorded following development and evaluation of alternative management strategies.

_____ Develop at least one, but preferably several, alternative management strategies (including structural improvements if needed) which have a good likelihood of being economically viable (see "Step 4" pages 10-12) and record a brief description of each in the WQFARE Planning Summary Template (see "Planning" section).

- Additional examples and support material for selecting technically feasible practice combinations include "Attachment" #1, "Attachment" #4 and the following "Support Material": *Managing Kansas Grazingland for Water Quality* MF-2086, *Grazing Distribution* MF-515, *Stocking Rate and Grazing Management* MF-1118, *Prescribed Burning as a Management Practice* L-815.
- Additional reference material to help ensure that practice combinations are economically viable include: "Introduction" page 2, "Attachment" # 5, "Step 5" pages 13-18.

_____ Analyze the economic feasibility of any alternative practice combination(s) that include a large capital investment (see "Step 5" pages 13-16) by:

_____ Estimating annual net cash flows (see "Step 5" pages 13-14).

_____ Discounting cash flows (see "Step 5" pages 14-15).

_____ Calculating and interpreting net present value (NPV) estimates (see "Step 5" pages 15-16).

_____ Analyze the economic feasibility of alternative practice combinations not requiring a large capital investment using an enterprise budget comparison between baseline conditions (see "Evaluation") and the proposed alternative management strategies (see "Step 5" pages 16-17).

_____ Select your preferred alternative and record its details in the WQFARE Planning Summary Template (see "Planning" section).

_____ Develop any new objectives associated with your preferred alternative to meet enterprise and lifestyle goals and record them in the WQFARE Planning Summary Template (see "Planning" section).

_____ Develop an approach for monitoring progress toward achieving objectives and goals using records in the "Evaluation" section of the notebook as a baseline. Note that monitoring results could indicate the need for adapting management and/or objectives. If so, make appropriate revisions to the "Planning" section in the notebook and continue monitoring.

Introduction

Water quality associated with grazing land can be improved or impaired by management practices. The Kansas Grazing Land Water Quality program (KGLWQP) has developed a process to help grazing managers identify water quality risks and develop site-specific management measures[2] to improve water quality. This process is called Water Quality Financial Analysis and Resource Evaluation Stewardship Program (WQFARE). It is explained in detail in the remainder of this document.

WQFARE is a five step program. The first step involves an inventory of the physical landscape and grazing management infrastructure. Step two evaluates the potential for correcting concerns identified in step one as well as the labor and managerial characteristics of the current management system. Step three consists of an evaluation of the capital resources and financial viability of the current management system. Alternative management strategies are developed in step four, focusing on fundamental grazing management principles. Last, an analysis of economic feasibility of each proposed management strategy is performed.

How Grazing Affects Water Quality

The quality of water leaving grazing lands is primarily a function of interrelationships between precipitation (interval, duration, and intensity), landscape characteristics, and livestock use. One way livestock can impact water quality is by depositing manure and urine directly into water, impairing its quality due to the increased pathogens and nutrients. Heavy grazing and livestock concentration may also reduce vegetative cover needed to protect soil from erosion and to reduce runoff. Runoff from areas frequented by livestock can deliver (via over-land flow and gullies) excessive sediment, nutrients, bacteria, and other undesirable materials to streams, ponds and lakes. In addition, disturbances to ponds and stream banks caused by livestock can increase the level of suspended and/or dissolved materials in these surface waters. Erosion and sedimentation is a concern not only because it represents a resource loss, but also because excessive sediment may impact aquatic life and because many pollutants are transported attached to sediment particles.

Livestock Behavior

Interpreting livestock behavior can help managers identify and address water quality problems associated with livestock spending a disproportionate amount of time in localized areas of a pasture. The impacts associated with heavily-grazed areas and livestock concentration areas are frequently the source of water quality concerns. Watering point location(s) will usually be the most influential factor(s) determining where livestock prefer to concentrate, trail, or graze. Observing livestock behavior is important to understanding why problem areas are located where they are and what management measures can best address specific problems.

Vegetation

Vegetation density helps indicate whether management measures are needed for specific sites within a pasture because the presence of vegetation helps slow runoff and protect the soil from erosion. The potential risk a site poses to water quality also depends on the size and slope of the area, as well its proximity to water resources.

Adequate vegetative cover separating areas of potential concern from water resources is needed to

---

[2] A management measure is new EPA terminology signifying a group of affordable management practices used together to achieve a management goal

avoid or at least reduce pollutant discharge into water due to runoff. Figure 1 illustrates the importance of vegetative cover in reducing runoff and sedimentation, and is applicable to pollutant transport as well.

Interpretation of vegetative cover and hydrologic proximity (relative nearness to water resource) helps the evaluator prioritize sites to be monitored and/or addressed by management. Management measures should be developed to improve sites that are near water resources and not recovering under current management. For example, cover improvement in a drainage or riparian area might be accomplished simply by relocating a mineral feeder to an upland range site. However, some problems may require capital intensive investments such as cross-fencing and/or water development.

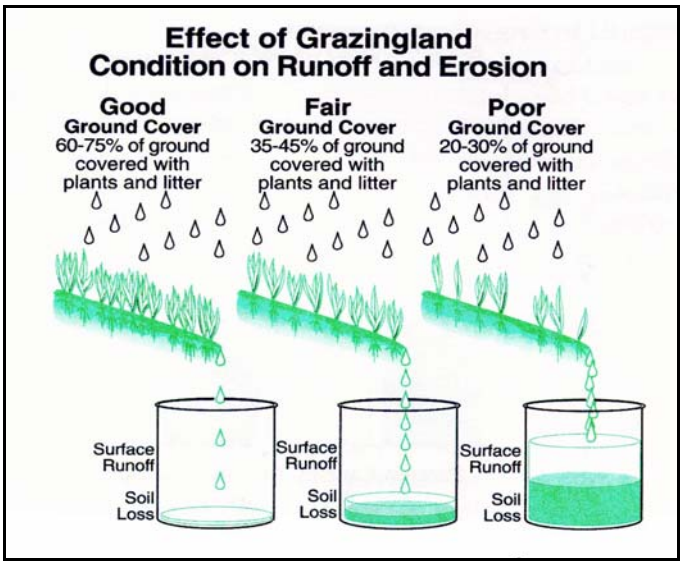


Figure 1. The effect of vegetative cover on runoff and erosion. (Adapted from Branson *et al.* 1981)

Management measures adopted for water quality improvement – like other management changes – must be affordable. Costs and benefits associated with the concepts/practices listed below are difficult to quantify but each has the potential to benefit both water quality and profitability.

- stocking at a moderate rate
-promoting even grazing distribution
-encouraging even distribution of manure and urine
-promoting more infiltration and less runoff (especially when water is the forage production limitation)
-providing clean water for optimal consumption and livestock performance
- controlling pests to improve production and reduce the effects of concentrated livestock
-alternating feeding areas (and pastures when possible) to improve utilization of hay and old grass, improve forage for next year and reduce water quality effects of concentrated livestock
-reducing or removing hazards (abandoned fences, mud, ice, steep stream banks)
-testing soil and timing fertilizer applications to avoid runoff or leaching

Consideration of these concepts will be helpful in developing management measures for water quality improvement. In some cases, implementing these generally low-cost practices will be sufficient for addressing water quality problems. However, when management practices are considered that involve significant capital investment an economic analysis is required prior to implementation.

STEP 1 - Inventory the Physical Landscape and Grazing Management Infrastructure

The inventory process is designed to help managers recognize problem sites while simultaneously acquiring information to be used for evaluating water quality and grazing management concerns. The condition of grazing land resources is influenced by relationships between livestock and their environment. Livestock activity within a pasture is determined by behavioral responses to landscape, environmental and management factors such as watering location, slope, forage quality, weather, pests, adjacent land uses (cropland, grazing land, roads, etc.) and the location of feed and mineral facilities. Visualizing the relationships between these factors (both on a map and from within the pasture concerned) can be help in determine sources/causes for conditions found at problem sites.

Characteristics of Problem Sites

Potential problem sites can be characterized as having exposed soil and/or poor vegetative cover. The significance of a problem depends on the degree of de-vegetation and/or soil exposure and the proximity of the site relative to water resources. Adequate separation (influenced by cover, slope and distance) between problem sites and water resources is needed to reduce contaminant transport by runoff to streams, ponds, lakes and springs. Sites with more extreme conditions may require a larger area of separation to protect water resources. The following Attachments characterize potential problems associated with:

Heavily grazed areas (See Attachment 1a)
Livestock concentration areas (See Attachment 1b)
Gully erosion due to trailing and/or excessive runoff (See Attachment 1c)

Performing Pasture Inventories

The pasture inventory entails identifying and locating any landscape and management features that likely affect livestock use patterns, (preferably with the aid of maps and/or aerial photography). Initial pasture inventories provide the manager a starting point for developing management measures that address problems identified and for monitoring improvement following their implementation.

The source of potential problems can be explained by studying how livestock respond to landscape and management features. The major factor influencing livestock activity, and consequently potential problem sites, is the location of preferred watering points. Watering preference is influenced by facility type, water quality, water quantity and the proximity of the facilities to other areas that attract livestock such as preferred shade and preferred grazing areas. The use of trees for shade or winter protection is also influenced by their location and the quality of protection they provide. Prevailing wind direction and topography also play an important role in attracting or discouraging the use of grazing areas, trees or watering facilities having similar qualities.

Procedure

1. Plan a systematic approach to thoroughly cover each pasture in the management unit being inventoried. A set of base maps should be arranged in an appropriate order to simplify the data collection and management.
2. Note the location of the features listed below for each pasture inventoried. To keep the base

map from becoming cluttered, it may be advisable to index it with a number corresponding to notes elsewhere (see Figure 2), or use additional copies of the base map for recording more detailed notes.

3.

Water resources – Note the location and condition of streams, ponds, troughs, springs, and wells. Also note any riparian or wetland areas.

Heavily-grazed areas – Note any heavily grazed areas encountered. Also suggest if possible, the probable reason for heavy use – such as mineral feeder location, proximity to water, shade, etc.

Concentration areas – Note areas where livestock concentration is evident. Suggest possible reasons for the noted concentration.

Erosion – Note the location, extent, condition (active/recovering) and possible source(s) (trailing, cropland runoff, heavily grazed area, culvert, others) of any erosion present.

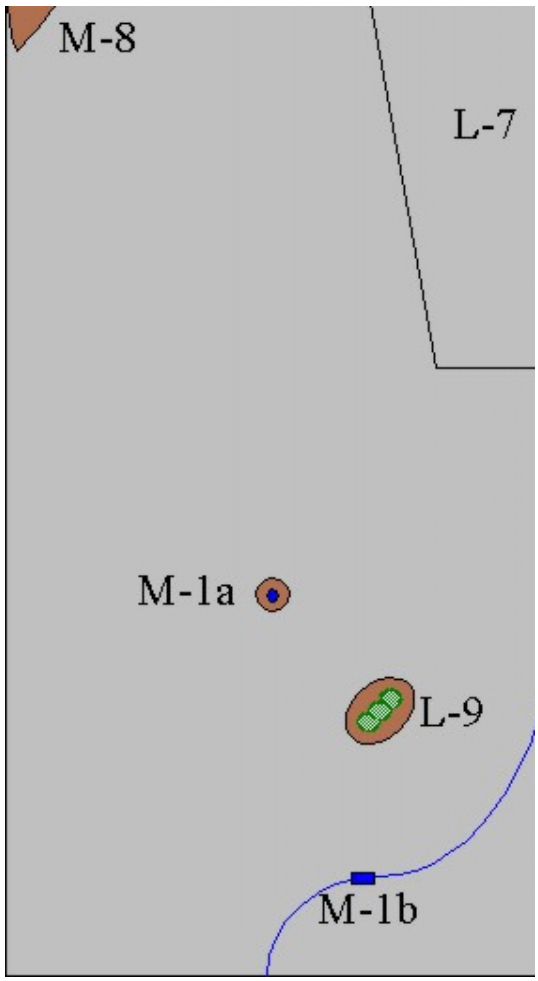
Features that affect livestock use patterns – Note the location and extent of the landscape and management features that affect livestock use patterns (see below).

Landscape features that affect livestock use patterns

1. prevailing wind direction
2. upland range sites
3. wind protection
4. lowland range sites
5. cool season grasses in native range
6. native grasses in cool season pasture
7. old crop or "go-back" fields
8. brush
9. shade
10. terrain (slope & ruggedness)
11. woodland
12. invasive weeds
13. others

Management features that affect livestock use patterns

1. watering points (ponds, troughs, accessible streams)
2. fences (especially separating other occupied pasture)
3. stream crossing used by livestock
4. fence corners
5. rubs and fly control facilities
6. mineral locations
7. haying areas/feed bunks
8. gates
9. abandoned fences
10. others



Landscape Features
L-7 – This old field has been back in grass for at least 60 years but ground cover is still only fair and livestock avoid this area.
L-9 – This is the most heavily used shade source. There is a gradual slope for about 200 ft leading to the stream. Cover between trees and stream is currently good but needs to be monitored as the grazing season progresses.

Management Features
M-1a – This trough is the primary water source for the pasture.
M-1b – This area on the stream is used for crossing, watering and wading
M-8 – Livestock concentrate around this gate.

Figure 2. Possible approach for indexing base map to correspond with field notes.

STEP 2 - Evaluating the Current Management System

Step two is an evaluation of the current management system which includes both the physical components inventoried for each pasture in step one and the managerial characteristics of the grazing enterprise. Evaluation of the current management system is designed to help managers:

- determine the source(s) of identified problems or concerns,
- developing options for correcting problems
- review current goals and practices
- locate appropriate sources of technical and/or financial assistance

Determining Problem Sources

Problem sources are determined by identifying the feature(s) and/or livestock behavior causing sites to have exposed soil and/or poor vegetative cover in close proximity to water resources. When identifying problem sources it should be recognized that some features will impact livestock use patterns at multiple sites. Ponds for example, not only encourage loafing and concentrated use near the pond, but also affect the use of available shade, mineral feeders etc. Also recognize that the use of individual sites may be influenced by multiple landscape and management features. For example, a group of trees on a hill (exposed to the wind) located between the watering source and desirable forage should be the preferred shading area over trees located elsewhere.

Non-grazing influences on site condition such as cropland runoff or culvert erosion should also be considered before evaluating the potential for correcting problems. Unless such a problem is causing a significant reduction in pasture productivity, it may be impractical, if not impossible, to address it with a grazing management measure. However, there may be value in documenting current conditions and changes over time so that future management decisions can take such trends into account.

Developing Options for Correcting Problems

The process described in this document targets the sources of water quality concerns that can be addressed by grazing management. Much of the potential to improve water quality associated with grazing land rests upon the ability of the manager to anticipate how livestock will respond to the implementation of management practices. Familiarity with livestock behavior will allow managers to identify practices that will reduce negative impacts associated with livestock concentration and heavily grazed areas. Managers should strive to implement practices that will improve grazing distribution, decrease concentration, and/or reposition areas of concentration or heavy grazing away from water resources.

Some problems may be corrected by simply adjusting basic management principles such as stocking rate, grazing distribution, season of use, kind and class of animal, and systematic rest . It may be desirable to implement a low-input/low-risk strategy first because it could address a water quality concern sufficiently, or at least provide insight into the potential for correcting the problem using a more costly management measure. A combination of practices coordinated into a management measure will often be necessary to correct the problem site(s) found in a pasture. The availability of practices suitable for implementing a water quality management measure will vary with the unique characteristics of pastures and the management system.

Determining a problem can potentially be corrected with a grazing management measure does not suggest that it can be implemented without subsidized incentives. Some management measures may not provide an adequate return on investment to justify the implementation cost. An

economic analysis may be needed to determine whether improvements are economically feasible, or to determine the amount of subsidized incentive needed to implement a desired water quality improvement practice.

Management Goals and Practices

Goals: Many grazing managers have goal statements identifying the type of business and lifestyle for which they strive. Some goals even identify desired recreational and environmental conditions. For operations with defined goals, water quality objectives can be included as a supplement to existing goals. Regardless of the explicit nature of enterprise goals, documentation of efforts to benefit water quality may be of future value as public demand for water resources increase and/or regulatory controls are implemented.

Practices: Reviewing the basic land, capital, and management inputs for each pasture in a management system helps catalog resources and identify strengths and weaknesses of the system. Performing such an assessment is necessary for establishing new management measures because environmental, economic, and regulatory/incentive factors change over time. A Management Information System (MIS) is recommended to first assess the current inputs and practices and later to develop management strategies for improving water quality. An MIS (in this context) is simply an organized system for storing, retrieving, and analyzing information necessary for administering the grazing enterprise.

Weaknesses found in grazing management systems will often be associated with an imbalance in the amount of land suitable for different uses. For example, few year-round grazing enterprises are fortunate enough to have an ideal combination of pastures suitable for winter use, spring/fall grazing and summer grazing. Managing for water quality enhancement can compound the challenge of achieving a balanced system. Adjustments that better match practices to the resources available may be necessary to accomplish both water quality and production goals. Management should also be flexible to take advantage of new information and/or innovation.

In addition, practices in some pastures may need to be changed to manage for improved water quality. However, changing practices in just one pasture could easily affect the whole management system. This is why it is important to look closely at not only the current use, but also the potential use of each pasture. Attachment 3 is provided to help characterize the kind of information and thought processes useful to evaluate both the physical and economic aspects of current management. These forms can serve as the pasture-specific components of the MIS.

Sources of Technical and/or Financial Assistance

The availability of assistance can depend upon the types of resource concerns found, the natural and/or political boundaries in which the property is located, and management goals and practices. Below is a list of potential sources of technical and/or financial assistance.

KSU Research and Extension
Natural Resources Conservation Service (NRCS)
Soil and Water Conservation Districts
Kansas Rural Center
State Conservation Commission
Others

Step 3 - Evaluation of the Financial Viability of the Current Management System.

This step includes developing accrual-adjusted beginning and ending balance sheets along with an enterprise-specific income statement for the existing management system. Current enterprise economic analysis provides a baseline profitability estimate with which to compare the economic projections associated with proposed changes.

Evaluation of Current Economics

Profitability of the current management system should be evaluated to develop a baseline for comparing changes proposed to improve water quality. Profitability estimates should be enterprise specific, and made based on accurate production and financial information.

Cow-calf operations pose unique evaluation problems. The production cycle for a cow-calf operation (breeding to weaning) is longer than a 12 month fiscal year, overlapping traditional accounting cycles. Furthermore, subsequent production cycles overlap each other as cows are bred for the next calf crop while nursing current year calves. Another complicating factor is that the cow-calf operation often shares machinery and other resources with cropping enterprises. Enterprise analysis for a cow-calf operation, therefore, is relatively complex.

Stocker operation enterprise analysis avoids the overlapping production/fiscal year problems associated with the cow-calf enterprise. Consequently, stocker enterprise analysis is simple relative to a cow-calf operation. However, given the complexity of estimating the profitability of a livestock operation in even a single year, standardized accounting methods have been developed to provide meaningful economic estimates.

Standardized performance analysis (SPA) was developed from a cooperative effort by the livestock industry and several universities to provide guidelines for handling complex enterprise analysis issues for livestock producers. SPA is a system of standardized procedures for measuring asset productivity and profitability of livestock enterprises. SPA is a recommended component of the MIS that provides information managers can use to improve production efficiency given available resources. Procedures allow individual producers to directly measure their productivity against industry benchmarks on a local, regional, and nationwide basis. Key performance measures generated by SPA include production costs per pound of animal produced, pounds produced per acre of grazing land, return on assets, and others. Table 1 presents an example of the key cow-calf production and financial variables calculated under SPA and the mean values for Kansas participants in the 1999 production year.

A critical component of any detailed enterprise analysis like SPA is collecting accurate financial and production data. Producing valid production and financial data requires detailed record keeping. A valid assessment of the profitability of a pasture should incorporate accrual adjusted financial statements (beginning balance sheet, balance sheet, and income statement). Accrual adjusted financial statements account for changes in the value of non-cash assets such as herd inventory. The primary information needed is herd inventory throughout the year, along with feed and land resources used by the grazing enterprise. Technical assistance in developing enterprise profitability estimates is available through Kansas State University Department of Agricultural Economics. Data collection forms for the appropriate enterprise can be obtained from local Extension offices.

Table 1. Production and Financial Variables and Mean Values from Kansas Cow-Calf Producers.

----------Production Measures— ----------	
Herd Related Measures	
Pregnancy Percentage	95.5%
Calving Percentage	97.8%
Calf Death Loss Based on Exposed Females	3.9%
Calf Crop or Weaning Percentage	93.6%
Actual Weaning Weight, steers/bulls (lbs)	541
Actual Weaning Weight, heifers (lbs)	517
Average Weaning Weight (lbs)	532
Pounds Weaned per Exposed Female	488
Other Physical Performance Measures	
Grazing Feed Acres per Exposed Female	8.9
Pounds Weaned per Acre Utilized by the Cow-Calf Enterprise	57.3
Pay Weight Prices per Cwt.	
Weaned Calf Pay Weight - steers/bulls	$ 87.61
Weaned Calf Pay Weight - heifers	$ 81.61
Weaned Calf Pay Weight - weighted average	$ 85.41
----------Financial Measures----------	
Investment & Returns (ROA)	
Total Investment Per Breeding Cow	$ 1,430.69
Percent Return on Assets - market value	5.3%
Financial Performance	
Raised/Purchased Feed Cost per cow	$ 116.01
Grazing Cost per cow	$ 130.04
Total Cost Before Noncalf Revenue Adjustment per cow	$ 383.18
Total Cost Before Noncalf Revenue Adjustment per cwt	$ 74.63
Total Cost Noncalf Revenue Adjusted per cow	$ 281.62
Total Cost Noncalf Revenue Adjusted per cwt	$ 59.48
Net Income After Withdrawals per cow	$ 49.70
Net Income After Withdrawals per cwt	$ 6.51
Economic Performance	
Total Cost Noncalf Revenue Adjusted per cow	$ 354.00
Total Cost Noncalf Revenue Adjusted per cwt	$ 74.56
Net Income After Withdrawals per cow	$ - 43.72
Net Income After Withdrawals per cwt	$ - 8.57

STEP 4 Alternative Management Strategy Development

Considering the current goals, practices and financial viability of the operation while developing alternative management strategies helps ensure desirable alternative practice combinations are identified. The fundamental grazing management principles of stocking rate, grazing distribution, season of use, kind and class of animal, and systematic rest are central to developing alternative management strategies. The objective of management changes proposed for improved water quality is typically to relocate concentration and heavily-grazed areas away from water resources based on the anticipated response of livestock. Practices that promote more uniform grazing distribution and vegetative cover often become a part of alternative management strategies. Another common component is a permanent or periodic change in the location of facilities associated with concentration areas.

Developing New Management Measures

New practice combinations that benefit water quality are developed based the results of the pasture inventory and evaluation. For example, the right columns in Attachments 1a and 1b show anticipated improvements resulting from measures to address heavily-grazed areas and concentration areas respectively. At least one, but preferably several possible alternatives should be developed. Alternatives for consideration should include different possible combinations of practices that will relocate heavily grazed and concentration areas to more desirable areas. This involves envisioning desired livestock use patterns and management adjustments needed to accomplish them.

Water quality improvement practices considered should generally encourage grazing in under-utilized upland portions of pastures and discourage livestock trampling, manuring and over-grazing areas sensitive to water quality degradation, such as riparian areas. Depending upon specific pasture conditions, management strategies that include one or more of the following adjustments may benefit water quality:

Changing watering facility type and/or location
Reducing the stocking rate to a moderate level
Implementing prescribed burning
Controlling undesirable trees and brush
Changing feeding site periodically to reduce pollutant concentration
Alternating feeding locations to improve spring/summer productivity and grazing distribution
Discontinue feeding near streams and in drainages
Adding and/or removing fences to improve grazing distribution
Relocating mineral supplements
Providing shelter belts or artificial wind protection away from water resources
Promoting use of upland shade
Resting pasture for a period during the growing season

The following attachments can be used as a guide to help select practices to be incorporated into management measures targeted at water quality issues on grazing land.

Water Protection Management Measures for Grazingland (Attachment 4)
Draft Qualitative Practice Selection Table (Attachment 5)

Developing Economially Viable Management Strategies to Improve Water Quality

Developing an affordable management strategy generally involves much more than changing

how livestock use the pasture. Realistic alternatives must be compatible with the unique combination of management ability, resources (land, labor, capital) and objectives of each operation. Changing grazing management to enhance water quality involves developing new goals or modification of existing goals, developing new or modified management measures, and an evaluation of the economic risk and feasability for each alternative management strategy.

Many of the profitability measures commonly used in agriculture can be misleading. This is especially true when comparing fundamentally different alternatives, or when comparing enterprises of significantly different scale. Basing management decisions on net farm income, gross margin, returns per acre, or returns per head comparisons often leads to economically inferior management strategies. The Farm Financial Standards Council suggests two primary measures of profitability, rate of return on assets, and rate of return on equity. These measures scale net income to the capital resources required to achieve it. SPA provides the framework for calculating these values.

Economic Analysis of Structural Improvements

The economic feasibility of proposed capital improvements should be evaluated using standard capital budgeting procedures. Capital budgeting refers to the process of planning expenditures on assets whose cash flows are expected to extend beyond one year. Capital budgeting decision rules commonly applied in grazing land situations are net present value (NPV), benefit cost ratio (B/C), and internal rate of return (IRR). Under certain conditions, these common measures can yield conflicting results. When this occurs, NPV is generally considered the superior method of evaluating capital investments or management alternatives.

NPV and B/C are similar. NPV is defined as the difference between the sum of discounted cash inflows and outflows, while B/C is the sum of discounted benefits divided into the sum of discounted costs. IRR is defined as the discount rate that equates NPV to zero.

Capital budgeting decision rules are all discounted cash flow (DCF) procedures. DCF procedures discount future cash flows to account for the time value of money when considering investments or management measures. A basic principle of financial management is that a dollar today is worth more than a dollar tomorrow (Brealey and Myers). Cash on hand today could be invested to generate future income, or retire debt and reduce interest expenses. To make a fair comparison of cash flows occurring at different time periods, they should be adjusted to a common point in time, typically the present value. Discounting, the mathematical reverse of compounding, is the process of converting future cash flows to their present value.

Capital budgeting criteria favor projects with more immediate benefits. For example, technology that can shorten initial grazing deferments would be more valuable to a livestock operation than extending the life of a seeded stand of grass. Projects or management changes that require a large initial investment, or do not return benefits until several years into the future, rarely generate a positive discounted net return to a livestock producer.

Unfavorable economic evaluations of grazing land improvements are often criticized as short sighted because some would assume that a project which permanently improves pasture condition and productivity will eventually pay for itself. While this rationale is intuitive, it does not recognize the time value of money. At a 7% discount rate, the present value of an investment returning $100 per year never exceeds $1,430, even with an infinite time horizon. Capital costs, therefore, impose a limit to the private benefit of improved pasture productivity. Consequently, pasture improvements requiring excessive up front investment will never pay off, even if benefits continue perpetually. Properly estimated capital budgeting results are considered long term feasibility estimates.

STEP 5 - Analysis of economic feasibility of each proposed management strategy

An analysis of the economic feasibility of each proposed management strategy is performed in the final step of the WQFARE process. Capital budgeting decision rules are recommended to evaluate potential improvements requiring long term capital investment. Other management changes will be evaluated using partial budgeting or full enterprise analysis. This process helps determine which alternative management strategies are viable, and help rank expected costs and benefits associated with the alternatives. In some cases the process helps to determine the amount of "cost share" funding that may be needed to implement a strategy.

Evaluating the economic feasibility of proposed management measures

Step by step instructions for calculating NPV and other capital budgeting measures are presented in several financial management texts and extension publications, with a variety of ways to approach the problem. At a minimum, however, any capital budgeting estimate should contain the following elements:

1) an estimate of the annual net cash flows generated by the improvement;
2) cash flows discounted at an appropriate rate to determine present value,
3) computation and interpretation of the NPV estimate.

Estimating Annual Net Cash Flows

The initial step in developing a capital budgeting feasibility estimate is projecting net cash flows generated each year over the life of the improvement. Improvements or management changes generate net cash flows by increasing productive capacity, and/or reducing operating costs. Information needed to estimate annual cash flows generated by range improvement practices includes: 1) physical responses such as changes in livestock or forage production; 2) the value of physical changes, represented by forage or livestock prices; 3) the costs associated with implementing the changes; 4) the life of the improvement.

Physical production changes resulting from a range improvement can be valued either in terms of forage production or livestock production. Forage value changes would typically be represented by prevailing grazing lease rates or hay prices. Changes in livestock production values would be represented by added production multiplied by the relevant price. Due to the dynamic and complex nature of livestock prices, valuing changes in livestock production is typically more complicated than valuing changes in forage production. Cash flow estimates require information about the relationship between forage and livestock production. Seasonal impacts related to forage balance within the overall livestock operation may also need to be considered when evaluating major grazing land management changes.

Partial budgeting is a common method used for estimating cash flows. Partial budgeting simplifies the cash flow estimation process by considering only costs and returns impacted by the management change or capital investment. To aid managers estimating cost components, example budgets for various management practices are typically available from extension and other sources.

SPA analysis evaluates profitability on a enterprise-wide basis. Evaluating the economic impact of management changes or capital improvements requires baseline profitability estimates of the individual pasture under consideration. In this case an enterprise wide profitability estimate may not be adequate. The baseline profitability estimate may need to be estimated for specific pastures.

Cash flow estimates should be based on an incremental changes in costs and/or revenues associated with the investment. The relevant comparison is the difference between cash flows generated by the proposed investment and the next best alternative. For example, the profitability of a new water system should be based on how productivity is impacted relative to productivity without the water system. A common error in feasibility analysis is estimating the profitability of

the water system by evaluating the profitability of operating a cattle enterprise. Estimating incremental cash flows requires the analyst to understand which costs change. Average costs calculated from standard accounting procedures include an allocation for overhead and other fixed costs.

Producers considering a substantial capital improvement should understand the difference between cash flow and profitability. A project may be profitable but may not be feasible for producers unable to meet the cash flow requirements. A project may be profitable in the long run but not financially feasible if the investment creates liquidity problems. Liquidity refers to whether there is enough cash on-hand to pay bills as they come due.

Discounting Cash Flows

To accurately assess the financial impact of capital improvements or management changes, cash flows projected to occur in the future should be discounted to their present value. A simple method of discounting cash flows to their present value is multiplying each projected cash flow by the appropriate discount factor. The appropriate discount factor is determined by the discount rate and the year in which the cash flow occurs. Discount factor tables are available in financial management texts and other sources. Table 2 lists discount factors over a range of discount rates for projects having a useful life ranging from 1 to 50 years. Financial calculators and popular spreadsheet software will readily compute present value.

The economic feasibility of range improvements depend largely on the discount rate used in the analysis. The discount rate should reflect the minimum rate of return management is willing to accept on the investment, which in most cases, would be the expected rate of return on competing investment alternatives. The appropriate discount rate also depends on the operator cost of capital, prevailing interest rates in the general economy, and the risk associated with the investment. The importance of proper discount rate selection increases as the useful life of the planned improvement.

An important issue to consider when developing cash flow and discount rate estimates over a multi-year period is inflation. Inflation refers to the increase in the price level of goods and services in the economy over time. Rising prices impact future income projections through livestock prices and production costs. Cash flows estimated from prices that include inflation are considered "nominal." By contrast, cash flows estimated from prices that have the inflation component removed are considered "real."

Like cash flows, interest rates can be expressed as nominal or real. Nominal interest rates include a premium equal to the expected rate of inflation. Interest rates observed in the capital and money markets are typically nominal rates. To convert the interest rate from a nominal to a real basis, the expected rate of inflation should be subtracted from the nominal interest rate.

Capital budgeting analysis can be done with either real or nominal cash flows. The inflation assumption should be consistent between discount rates and cash flows. If projected cash flows were estimated on a nominal basis, a nominal discount rate should be used. Projecting future cash flows using current price and cost levels, as done in the example shown in Table 2, implicitly assumes real cash flows. A real discount rate, therefore, should also be used in this situation.

The risk associated with a particular range improvement will impact the results of a feasibility estimate. The second basic principle of financial management (Brealey and Myers) states that a safe dollar is worth more than a risky one. Consequently, riskier investments typically require a higher return. Financial markets implicitly add a risk premium to the return on financial assets. Adding a premium to the discount rate, therefore, is a common method of adjusting for risk. However, deriving a risk-adjusted discount rate on a specific physical asset is often difficult. An alternative approach is to use the discount rates typically applied to similar investments. Real

Table 2. Discount Factors: Present Value of $1 to be received after n years = $1/(1+ i)^n$

Year	4%	5%	6%	7%	8%	9%	10%	12%	14%	16%
1	0.9615	0.9524	0.9434	0.9346	0.9259	0.9174	0.9091	0.8929	0.8929	0.8920
2	0.9246	0.9070	0.8900	0.8734	0.8573	0.8417	0.8264	0.7972	0.7972	0.7972
3	0.8890	0.8638	0.8396	0.8163	0.7938	0.7722	0.7513	0.7118	0.7118	0.7118
4	0.8548	0.8227	0.7921	0.7629	0.7350	0.7084	0.6830	0.6355	0.6355	0.6355
5	0.8219	0.7835	0.7473	0.7130	0.6806	0.6499	0.6209	0.5674	0.5674	0.5674
6	0.7903	0.7462	0.7050	0.6663	0.6302	0.5963	0.5645	0.5066	0.5066	0.5066
7	0.7599	0.7107	0.6651	0.6228	0.5835	0.5470	0.5132	0.4523	0.4523	0.4523
8	0.7307	0.6768	0.6274	0.5820	0.5403	0.5019	0.4665	0.4039	0.4039	0.4039
9	0.7026	0.6446	0.5919	0.5439	0.5002	0.4604	0.4241	0.3606	0.3606	0.3606
10	0.6756	0.6139	0.5584	0.5083	0.4632	0.4224	0.3855	0.3220	0.3220	0.3220
11	0.6496	0.5847	0.5268	0.4751	0.4289	0.3875	0.3505	0.2875	0.2875	0.2875
12	0.6246	0.5568	0.4970	0.4440	0.3971	0.3555	0.3186	0.2567	0.2567	0.2567
13	0.6006	0.5303	0.4688	0.4150	0.3677	0.3262	0.2897	0.2292	0.2292	0.2292
14	0.5775	0.5051	0.4423	0.3878	0.3405	0.2992	0.2633	0.2046	0.2046	0.2046
15	0.5553	0.4810	0.4173	0.3624	0.3152	0.2745	0.2394	0.1827	0.1827	0.1827
16	0.5339	0.4581	0.3936	0.3387	0.2919	0.2519	0.2176	0.1631	0.1631	0.1631
17	0.5134	0.4363	0.3714	0.3166	0.2703	0.2311	0.1978	0.1456	0.1456	0.1456
18	0.4936	0.4155	0.3503	0.2959	0.2502	0.2120	0.1799	0.1300	0.1300	0.1300
19	0.4746	0.3957	0.3305	0.2765	0.2317	0.1945	0.1635	0.1161	0.1161	0.1161
20	0.4564	0.3769	0.3118	0.2584	0.2145	0.1784	0.1486	0.1037	0.1037	0.1037
25	0.3751	0.2953	0.2330	0.1842	0.1460	0.1160	0.0923	0.0588	0.0588	0.0588
30	0.3083	0.2314	0.1741	0.1314	0.0994	0.0754	0.0573	0.0334	0.0334	0.0334
40	0.2083	0.1420	0.0972	0.0668	0.0460	0.0318	0.0221	0.0107	0.0107	0.0107
50	0.1407	0.0872	0.0543	0.0339	0.0213	0.0134	0.0085	0.0035	0.0035	0.0035

discount rates ranging from 4 to 8% are commonly used to evaluate rangeland improvements although recent research suggests that the risk-adjusted real rate of return on most agricultural assets falls between 5 and 9%.

Calculating and Interpreting the NPV Estimate

NPV is simply the sum of discounted cash flows, whether negative or positive, over the life of the improvement. A zero NPV is considered the break-even point and implies the project yields a rate of return equivalent to the discount rate. Any project with an expected NPV greater than zero is projected to be economically feasible. When choosing between several alternatives, the project carrying the greatest NPV is the economically preferred choice. Similarly, a benefit cost (B/C) ratio equal to one implies total benefits equal total costs. Any project with a B/C greater than or equal to one, therefore, is projected to be economically feasible.

An alternative method of estimating the economic feasibility of a capital investment is internal rate of return (IRR). IRR is defined as the discount rate that equates NPV to zero. Financial calculators and computer software can quickly calculate IRR, which is expressed as a percent rate of return. The accept/reject decision criteria is whether the IRR exceeds the opportunity cost of capital. This is often more intuitive than interpreting a summed dollar value. IRR should be interpreted carefully, however, because results are sensitive to underlying assumptions regarding the re-investment of positive cash flows.

Example NPV Problem

Table 3 shows an example of a simple NPV problem. The second and third columns contain estimated cash outflows and inflows fo each corresponding year over the ten year useful life of the project. Estimated cash outflows consist of a $3,000 initial investment and a $300 annual maintenance cost. Expected cash inflows increased gradually until reaching $1,000 in year 3, and then tapered off after year 6. The last column lists NPV accumulated each year of service. This investment would break-even after 8 years. The net present value after a 10 year useful life is estimated to be $213.

Economic Analysis of Managerial Practices

Management strategies recommended to improve water quality may not require a large capital investment. For example, adjusting stocking rate or switching to early intensive grazing or rotational system may not require a substantial capital investment but may have a profound impact on profitability. Formal capital budgeting may not apply in this situation. The economic impact can be estimated with an enterprise budget comparison between the existing and proposed management strategy.

Alternative Grazing Systems

Care should be taken when evaluating alternative grazing systems with substantially different acreage and head requirements. Calculating profitability on a per acre or per head basis can yield misleading and even conflicting recommendations. The most reliable measure of profitability is rate

Table 3. An example net present value problem assuming a 6% discount rate.

Year	Cash Outflow	Cash Inflow	Net cash Flow	Discount Factor	Discounted Cash Flows	NPV
0	3,000	0	-3,000	1.0000	-3,000	-3,000
1	300	500	200	0.9434	189	-2,811
2	300	700	400	0.8900	356	-2,455
3	300	1,000	700	0.8396	588	-1,868
4	300	1,000	700	0.7921	554	-1,313
5	300	1,000	700	0.7473	523	-790
6	300	1,000	700	0.7050	493	-297
7	300	700	400	0.6651	266	-31
8	300	500	200	0.6274	125	94
9	300	500	200	0.5919	118	212
10	300	300	0	0.5584	0	213
Salvage Value			0	0.5584	0	213

of return on assets or rate of return on equity. However, when comparing potential grazing systems with a common acreage requirement, returns per acre will generally yield the correct choice.

A key concept in developing a budget comparison is identifying which cost values will be impacted by a management change. In some cases, water quality improvements may require a stocking rate reduction. An important consideration in an economic evaluation of a stocking rate change is the trade-off between stock density and per head weight gain. As stock density increases, inter-animal competition for forage increases, reducing individual weight gain.
This relationship limits the number of animals that can be profitably grazed on a given land area. Calculating the economic impact of a stocking rate reduction is generally more complex than simply

multiplying average per head income with the number of animals reduced. Reducing the stocking rate will typically improve per head performance, mitigating (and possibly offsetting) the reduction in total beef production on a per acre basis.

When considering management strategies that impact grazing capacity, an important issue to consider is whether forage improvements will be captured through increased stocking rates, individual weight gain, or some combination. A simple budgeting exercise demonstrates that increasing average daily gain is much more favorable economically than increasing stocking rate. Increasing stocking rates require investment in additional livestock and associated veterinary care and other costs typically incurred on a per head basis, but remain constant on a weight gain basis.

Prescribed Burning

Prescribed burning is a common grazing management tool in the Flinthills region. Excess forage in under-grazed areas provides potential fuel while forage in over-grazed areas is depleted and will not carry a fire. New growth in burned areas is generally more palatable and favorable to livestock (Owensby and Launchbaugh, 1978). Burning, therefore, improves grazing distribution by attracting cattle to less desirable areas of the pasture. Burning also controls undesirable brush and trees, thereby reducing herbicide requirements.

Spring burning appears to improve stocker animal performance. Owensby and Launchbaugh (1978) reported a study in the Kansas Flinthills between 1950 and 1967. Spring burning improved total weight gains of steers stocked at 3.3 acres per head by 11% in pastures burned May 1. Cow-calf production, however, does not appear to be significantly affected by burning.

The per acre cost of burning depends on the pasture characteristics (size, shape, terrain). An Oklahoma study conducted in 1987 estimated average per acre burning costs on a 160 acre pasture at $2.32. A study conducted by the Noble Foundation on three separate Oklahoma ranches estimated burning costs of $0.23, $0.35, and $4.64 per acre. The cost differences were attributed to different levels of fireguard preparation. This study concluded that annual burning improved the present value of a 10 year income stream of a typical stocker operation by $69 per hectare on shallow prairie and $4.80 per hectare on eroded prairie. Furthermore, prescribed burning reduced the frequency that annual returns fell below zero, implying a reduction in risk.

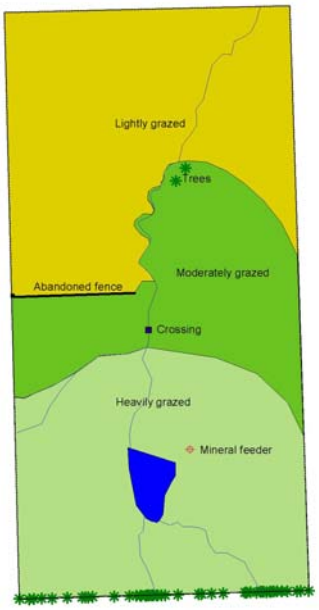
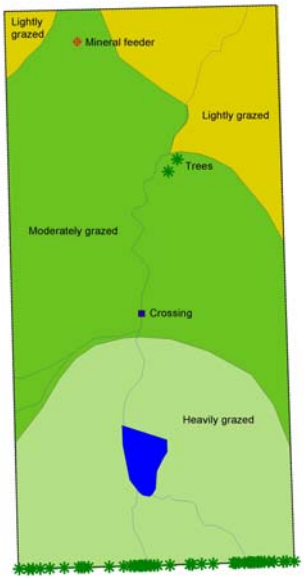
Sensitivity Analysis

Any economic evaluation requires an estimate of projected livestock prices, production costs, productivity impact and other variables. These forecasts cannot be identified with any degree of certainty. Deriving economic impact estimates will inevitably require assumptions regarding these variables using estimates based on the best available information. Sensitivity analysis is a tool used to identify the sensitivity of the results to changes in the underlying assumptions. Some variables may be highly uncertain, but the exact values make little difference to the results. For example, the precise useful life of long term assets such as fences, wells and storage tanks bears very little impact on the economic estimate. Conducting sensitivity analyses on these variables, therefore, may not be worthwhile. On the other hand, the discount rate and livestock production figures carry a large impact on economic feasibility.

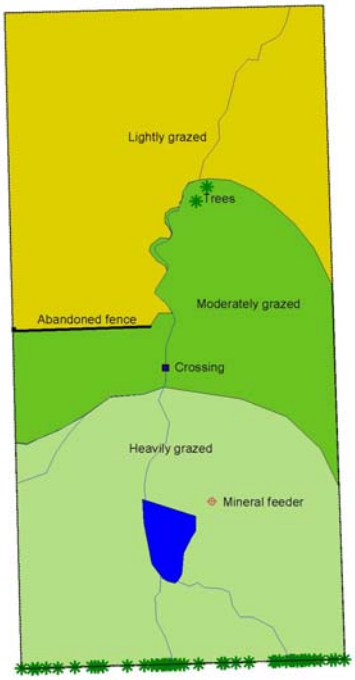
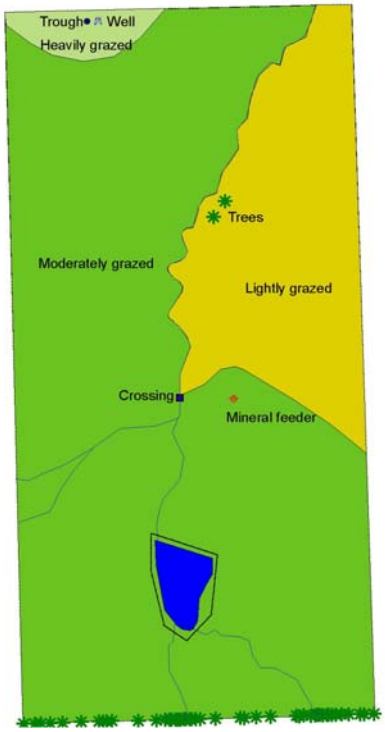
ATTACHMENT 1

A. Sample Management Measures for Grazing Distribution
B. Sample Management Measures for Concentration Areas
C. Sample Management Measures for Erosion Due to Trailing

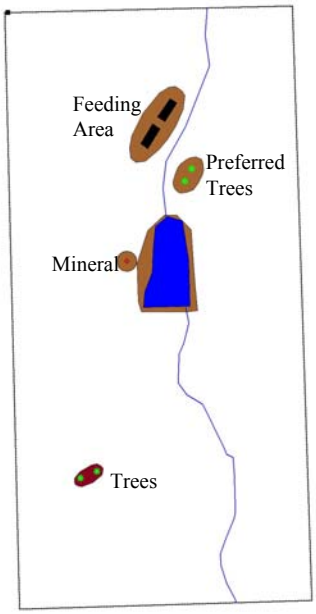
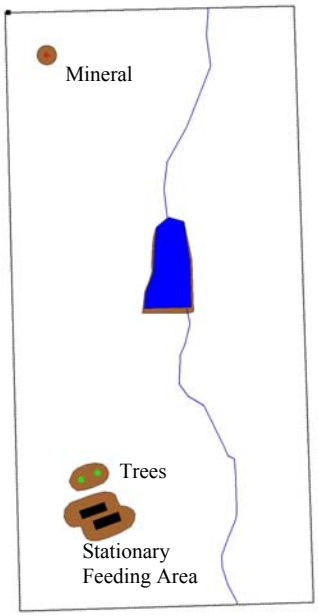
A. Low Input Grazing Distribution Management Measure

	Current Conditions	Potential Conditions
Example Pasture		
Characterization	Poor grazing distribution due to: - pond location - shade along the south fence - prevailing southerly winds - mineral location - abandoned fence - undesirable species increasing	Improved use of North part of pasture due to: - mineral location - removal of abandoned fence Continued use of remainder of pasture due to: - prevailing southerly winds - shade along south fenceline
Management Implications	Profitability: - declining production - abandoned fence is a hazard Water quality from heavily grazed area: - high levels of nutrients and bacteria - excessive runoff due to depleted vegetative cover	Profitability: - improved forage quality and utilization - reliable water supply Water quality influences throughout the pasture benefits from: - reduced runoff - improved distribution of waste
Proposed Practices	1) Remove abandoned fence. Cost: $100 2) Move mineral feeder closer to crossing. Cost: None 3) Burn every 3 years to improve distribution. Cost: $160	Monitor the impact changes for improved distribution have on: - forage quality and utilization - economic impact of management measure - use of original and new concentration areas - vegetative cover throughout the pasture

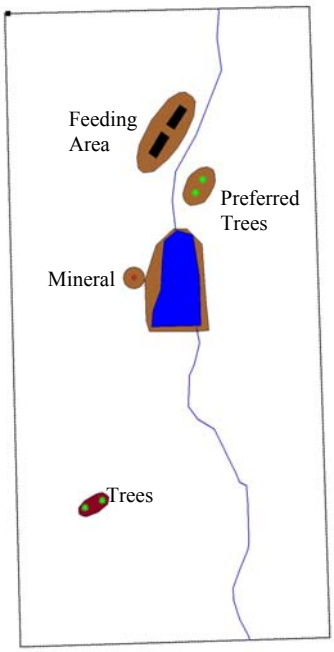
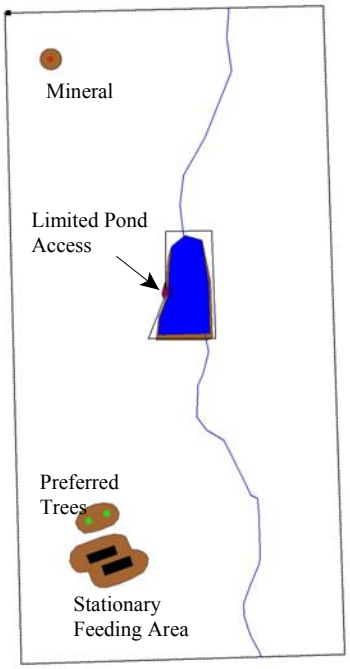
A. High Input Grazing Distribution Management Measure

	Current Conditions	Potential Conditions
Example Pasture		
Characterization	Poor grazing distribution due to: - pond location - shade along the south fence, - prevailing southerly winds - mineral location - abandoned fence - undesirable species increasing	Improved use of North part of pasture due to: - trough location - removal of abandoned fence Continued use of remainder of pasture due to: - mineral location - prevailing southerly winds - shade along south fenceline
Management Implications	Profitability: - declining production - abandoned fence is a hazzard Water quality from heavily grazed area: - high levels of nutrient and bacteria - excessive runoff due to cover condition	Profitability - improved forage quality and utilization - reliable water supply Water quality: - reduced runoff - improved distribution of waste
Proposed Practices	1) Remove abandoned fence. Cost: $100 2) Move mineral feeder closer to crossing. Cost: None 3) Burn every 3 years to improve distribution. Cost: $160 4) Fence out pond and develop water source in the NW part of pasture. Cost: $3000 initial; $100/year maintenance	Monitor the impact changes for improved distribution have on: - forage quality and utilization - economic impact of management measure - use of original and new concentration areas - vegetative cover throughout the pasture

B. Low Input Concentration Area Management Measure

	Current Conditions	Potential Conditions
Example Pasture		
Characterization	Exposed soil and trampled vegetation: Around pond due to: - Mineral and feed near pond -Preferred trees near feed and pond - Uncontrolled access to pond Near stream due to: - Preferred tree location - Feeding area location	Concentration areas located away from water resources. Mineral site and hay and cube feed locations can improve forage use. Feed site encourages use of SW trees. Cover will increase near water resources.
Management Implications	Profitability: - Pond filling with silt reduces water storage capacity and creates a hazzard. - Pond water quality may be reducing water consumption and/or promoting disease and thus reducing livestock productivity. - Forage away from water is under-utilized Water quality: - Feed, mineral and preferred tree locations encourage concentration near water resources	Profitability: - Extended pond life (less sediment) - Improved forage use reduces feed costs Water quality: - Improved vegetative cover near water resources
Suggested Practices	Move mineral and stationary feeding facilities to other suitable locations. Remove trees near pond if necessary. Alternate hay and cube feeding locations and/or season of pasture use.	Monitor the impact practices to reduce or relocate concentration areas have on: - Water consumption and animal health - Feed costs and productivity - Forage utilization - Vegetative cover near water resources

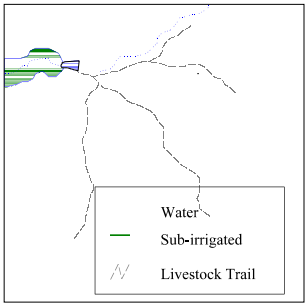
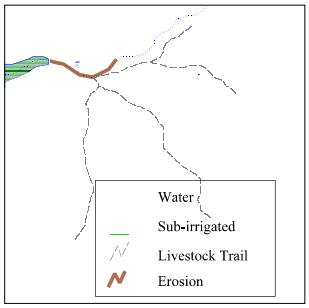
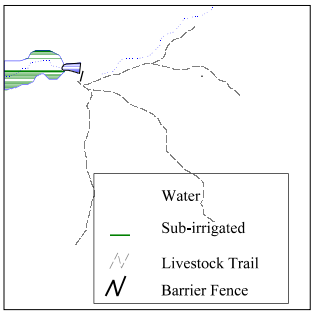
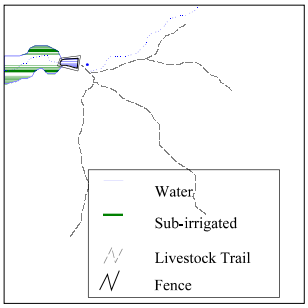
B. High Input Concentration Area Management Measure

	Current Conditions	Potential Conditions
Example Pasture		
Characterization	Exposed soil and trampled vegetation: Around pond due to: - Mineral and feed near pond - Preferred trees near feed and pond - Uncontrolled access to pond Near stream due to: - Preferred tree location - Feeding area location	Concentration areas located away from water resources. Mineral site and hay and cube feed locations can improve forage use. Feed site encourages use of other trees. Cover will increase near water resources.
Management Implications	Profitability: - Pond filling with silt reduces water storage capacity and creates a hazzard. - Pond water quality may be reducing water consumption and/or promoting disease and thus reducing livestock productivity - Forage away from water is under-utilized Water quality: -Feed, mineral and preferred tree locations encourage concentration near water resources	Profitability: - Extended useful life of pond (less sediment) - Limited pond access can improve water palatability and reduce hazzards - Improved forage use reduces feed costs Water quality: - Improved cover and reduced waste near water resources - Reduced livestock waste entering water resources directly from animals
Suggested Practices	Move mineral and stationary feeders to other suitable locations. Alternate hay and cube feeding locations and/or alternate season of pasture use. Limit access to pond. Remove upland tree species near stream and pond if necessary to change use pattern.	Monitor the impact practices to reduce or relocate concentration areas have on: - Water consumption and animal health - Feed costs and productivity - Forage utilization - Vegetative cover near water resources

C. Erosion Due to Trailing and Excessive Runoff (Fencelines)

				
Erosion status	No significant erosion along fence.	Stable erosion along fence with some sloughing along slope.	Unstable erosion along fence with limited ground cover and sloughing on slope.	Active erosion along fence with active sloughing at the top of the slope.
Management	Manage pasture to minimize livestock trailing along fence.	Manage pasture to minimize livestock trailing along fence.	Barriers to trailing will allow vegetative cover to develop to stabilize the area.	Area is actively changing. Barriers to trailing will help stabilize the area.
Suggested	Grazing distribution	Grazing distribution Trailing barriers may help	Trailing barriers Grazing distribution Fencing as last resort	Trailing barriers including fencing
Assistance	Extension NRCS	Extension NRCS	Extension NRCS	Extension NRCS

C. Erosion Due to Trailing and Excessive Runoff (Spillways)

Current Conditions	Potential Problem	Low-Input Alternative	High-Input Alternative
			
Description: Livestock trailing to water typically select a direct, unobstructed and relatively flat path. This frequently results in a rut forming in the spillway of pond. In this example, grass in the subirrigated area upstream from the pond is subirrigated and highly productive. The channel below the pond carries water only during and immediately following runoff.	Description: Overflow from the pond cuts a deep channel through the trail in the spillway. The pond is quickly drained and head-cutting upstream gradually drains the riparian area.	Description: To avoid livestock trailing through the low point in the spillway a fence is built that extends from the top of the dam to a high point across the spillway.	Description: Fencing the pond and spillway and installing pipeline to deliver pond water to a trough below the dam is a reliable solution to prevent trailing in the spillway.
Assistance Available: Extension NRCS others	Management Implications: Productive forage and reliable watering source is lost. Water Quality Implications: Sediment and associated components that were contained by the dam contribute to pollutant loading. Increased flows also contribute to stream bed and bank erosion. Pollution buffering effect of riparian area may be permanently lost.	Management Implications: Three to five rods of standard fence with two well anchored braces can avoid premature pond reconstruction costs and prevent a permanent loss of subirrigated forage production. Water Quality Implications: Pollutant loading from the pond and in-stream erosion is avoided and the buffering effect of the riparian area is maintained.	Management Implications: Higher construction costs for the fence and watering facility may be recovered by improving livestock production. Cool, clean water can increase both water and forage consumption. Water Quality Implications: Pollutant loading from the pond and in-stream erosion is avoided and the buffering effect of the riparian area is maintained.